

Plant Wide Performance Monitor Bridges Resource Gap

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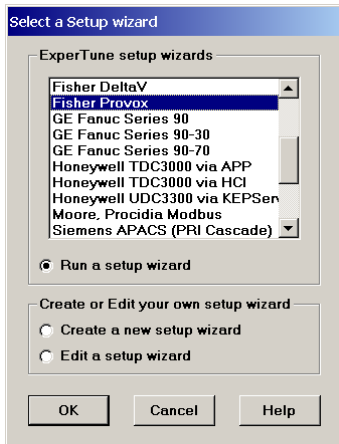
Processing plants are continually downsizing maintenance personnel in an attempt to reduce costs. These fewer maintenance people are required to fill an ever-increasing role. A performance monitoring package that prioritizes plant areas bridges this gap. The performance monitor prioritizes loops based on greatest economic gain. This prioritized list provides a springboard for action to be made. Maintenance can now be pro-active instead of scheduled.

The Performance Monitor is setup in 4 phases: 1) define or import the addresses for the process variables, 2) assign a relative economic priority to each loop, 3) Identify key performance indices to meet the business objectives of the plant, 4) apply templates to set the values of baselines and thresholds on the assessments for every loop. This setup phase can take between 1 and 4 days. The largest variable being the availability of an existing process control database to import in step 1.

After the setup, each loop is assessed at an interval defined for each unit operation in the plant. This interval can be set anywhere from 1 hour to 7 days on a unit operation basis. Assessments are compiled and the resulting overall performance of the plant, unit operation and individual loops are available in a web browser based user interface. Individual loop performance, economically weighted determines the position of the loop in the biggest payback list. Only the 10 worst performing loops appear in the list.

Loops appearing in the top 10 biggest payback loop list can be "snoozed". The purpose of a snoozing is to allow for those loops which the plant personnel know will be repaired at a certain date. This date is entered for each loop that is snoozed. All snoozed loops can be viewed in a snoozed list. The snoozed list shows the date snoozed and the person who snoozed the list.

PERFORMANCE MONITOR SETUP - DEFINE OR IMPORT LOOP ADDRESSES



The first step in setting up the performance monitor is connecting it to data for loops to be assessed. The performance monitor can either collect data real-time via OPC or can operate on data already collected in a plant historian using OPC Historical Data Access or HDA. In either case, the addresses for the loops PV, CO and optionally the setpoint, mode and PID parameters need to be defined.

The software includes individual loop wizards that make the setup easy and fast. The wizards require the user to enter only that information that cannot be determined from the control system by the software. For example, given an address of the PID block, the software can extract the PV, CO, SP, mode, controller type and PID parameter addresses directly.

An extension of the wizard technology allows the user to extract the tag information from the current DCS tag database into a CSV file. Or the user can enter the information into the CSV file. A CSV file is a comma delimited ASCII file. The monitoring software reads in this file and sets up all the loops.

PERFORMANCE MONITOR SETUP - ECONOMIC PRIORITY

For each loop an economic priority should be assigned. The economic priority indicates the relative importance of this loop to others in the plant. If 2 loops have the same health but different economic priorities, the one with the higher priority will bubble to the top of the Biggest Payback Loop list. This economic priority can be a column in the CSV file mentioned in the last section.

PERFORMANCE MONITOR SETUP - IDENTIFY KEY PERFORMANCE INDICES

Every plant will have different assessments that are significant contributors to the health of the control loops in that plant. The performance monitor allows each plant to choose different assessments to make up the definition of loop health.

Key assessments measuring loop health

Assessments important to your business. Checked assessments are those included in the "Average % towards threshold" calculation. See Help.

Only change these selections after careful consideration.

<input type="checkbox"/> Variability	<input type="checkbox"/> Robustness
<input checked="" type="checkbox"/> Avg abs error	<input type="checkbox"/> Relative response time
<input type="checkbox"/> SP crossings	<input type="checkbox"/> Model quality
<input checked="" type="checkbox"/> Output Standard Dev	<input type="checkbox"/> Process coef. 0
<input type="checkbox"/> Noise band	<input type="checkbox"/> Process coef. 1
<input type="checkbox"/> CO noise band	<input type="checkbox"/> Process coef. 2
<input checked="" type="checkbox"/> Harris (normalized)	<input type="checkbox"/> Process gain
<input type="checkbox"/> Harris index	<input type="checkbox"/> Process dead time
<input checked="" type="checkbox"/> Oscillating	<input type="checkbox"/> Process lag 1
<input checked="" type="checkbox"/> Osc - Hardware	<input type="checkbox"/> Process lag 2
<input type="checkbox"/> Osc - Tuning	<input type="checkbox"/> Process lead
<input type="checkbox"/> Osc - Load	<input type="checkbox"/> Oscillation strength 1
<input type="checkbox"/> Integral absolute error (IAE)	<input type="checkbox"/> Oscillation period 1
<input type="checkbox"/> Variance	<input type="checkbox"/> Oscillation strength 2
<input type="checkbox"/> Time in normal	<input type="checkbox"/> Oscillation period 2
<input type="checkbox"/> Valve reversals	<input type="checkbox"/> Oscillation strength 3
<input type="checkbox"/> Valve travel	<input type="checkbox"/> Oscillation period 3
<input type="checkbox"/> Output at limit	
<input type="checkbox"/> ExperTune index	

OK
Cancel
Help

Some assessments may not be important to certain types of loops. For example the average error on averaging level loops may not be an important indicator of their performance. The performance monitor allows specific key assessments be removed from individual loops or categories of loops.

PERFORMANCE MONITOR SETUP - APPLY TEMPLATES TO SET BASELINES AND THRESHOLDS

Each plant and business will have a different definition of loop health. What assessments determine a healthy plant for one business will be different for another. For example in paper mills, the variability of the paper is often a key assessment whereas in refineries the average error may be a key assessment.

The performance monitor allows every plant to specifically and easily set up their own definition of loop health. This is made available by the concepts of key assessments, baselines, thresholds and finally templates.

First the user adjusts the assessments that he feels are key to operation of his plant. He can choose any of 38 assessments. A typical list may comprise: Average Error, Output standard deviation, Harris index (normalized), Oscillation detection and Oscillation Diagnosis - Hardware. Below is a brief definition of each of these assessments:

Average Error is the average absolute error between the setpoint and measurement during the assessment period.

Output standard deviation is the simply the standard deviation in the controller output during the assessment period.

Harris Index (normalized): is a measure of the performance of the loop compared to minimum variance control. The index derives this information from normal operating data.

Oscillation detection is a value between 0 and 100%. 100% indicates confidence that the loop is continually oscillating.

Oscillation diagnosis is a value between 0 and 100%. 100% indicates confidence that the oscillation is caused from stiction or valve hysteresis.

Once key assessments are chosen the user decides on what an appropriate baseline would be for these key assessments. The baseline will be the value to compare against in the future. Ideally the baseline would reflect optimal operating conditions.

The threshold is the value of an assessment that we would prefer not to exceed. The definition of loop health is the average of each % towards threshold for the key assessments:

$$\% \text{ Towards Threshold} = (\text{Current Value} - \text{Baseline}) / (\text{Threshold} - \text{Baseline}) * 100$$

Loop Health = Average of the % Towards Threshold for all assessments on one loop.

The user sets up a template that define how the Performance Monitor will set baselines and thresholds over a time window chosen by the user. Once the template is setup the user simply directs the Performance Monitor to apply the template over a time period graphically chosen by the user.

Example Template settings for typical key assessments:

Assessment	Baseline	Threshold
Average Error	0	six sigma value
Output Std Dev	Average	six sigma value
Harris (normalized)	0	1
Oscillationg	0	100
Oscillationg - Harware	0	100

ASSESSMENT INTERVAL FOR EACH UNIT OPERATION

Every unit operation can have its own unique assessment interval that is meaningful to it. A unit operation with slow acting loops and long lag times should have a longer assessment interval than a faster acting unit operation. Unit operation sample intervals can be set anywhere from 1 hour to 1 week.

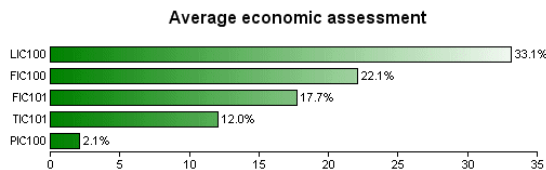
MAINTENANCE PRIORITIES AND THE BIGGEST PAYBACK LOOP LIST

The performance monitor includes a Biggest Payback Loop list. This is the list of the 10 worst behaving loops listed in priority order. The worst loop of all bubbles to the top of this list.

Biggest payback loops

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Loop name	Unit operation	Description	Health Index	Snooze loop
LIC100	Condensate	Knockout Drum Level	33.1%	Snooze
FIC100	Condensate	Condensate Return	22.1%	Snooze
FIC101	Feed Preheater	Condensate Flow	17.7%	Snooze
TIC101	Feed Preheater	Preheat Temperature	12.0%	Snooze
PIC100	Condensate	LP Steam Makeup	2.1%	Snooze



This list is probably the starting point for maintenance people with responsibility for keeping loops running well. Using this list boosts their productivity by a factor of 4 since they are hitting the loops that are the real problems in the plant. These are the loops whose health is impacting the bottom line of the business.

Once a loop is identified to be repaired on a specific date, it can be snoozed off the list. This prevents the false alarm predicament. The user who snoozes the loop enters a date when the loop is then available to appear in the Biggest Payback Loop list again. The snoozed loops can also be viewed in their own Snoozed Loop list.

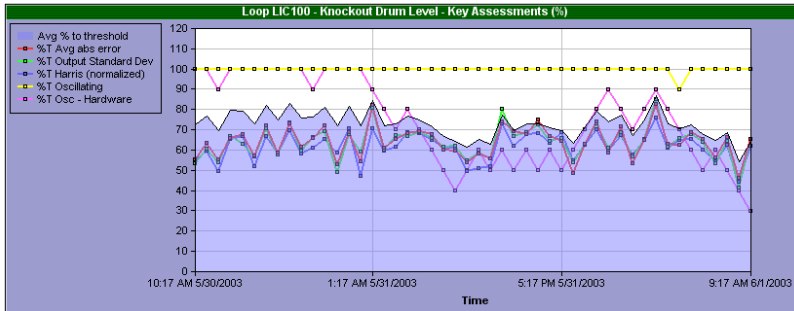
From the Biggest Payback Loop List, the user can drill-down to obtain detailed diagnostic information about what is going on in specific loops on the list.

DRILL-DOWN IDENTIFIES PROBLEM

Clicking on a loop name, drills down to see specific diagnostic history for that loop. The column "Oscillating" shows that the problem with this loop is an oscillation one. The "Diagnostic" column shows that the oscillation is probably caused by valve stiction or hysteresis.

The next step for the maintenance engineer would be to use the hysteresis and stiction testing tools in the software to quantify and verify the repair desired. After valve repairs are made the engineer would re-tune the loop using the integrated tuning tools and data already collected.

Loop History for Member of
 assess period snapshots over a day period.
 Ending now
 Columns to view:
[PlantTriage home page](#) [Loop list](#) [Manage columns](#)
[Condensate Unit history](#) [Help](#)



Latest data on the left Latest data on the right

Time	Avg % to threshold	%T Avg abs error	%T Output Standard Dev	%T Harris (normalized)	%T Oscillating	%T Osc - Hardware
<input type="button" value="Re-draw"/>	Trend <input checked="" type="checkbox"/>	Trend <input checked="" type="checkbox"/>	Trend <input checked="" type="checkbox"/>	Trend <input checked="" type="checkbox"/>	Trend <input checked="" type="checkbox"/>	Trend <input checked="" type="checkbox"/>
9:17 AM 6/1/2003	64.48	65.3%	65.3%	61.8%	100.0%	30.0%
8:17 AM	54.37	46.3%	41.5%	44.0%	100.0%	40.0%

PERFORMANCE INFORMATION AVAILABLE TO ANYONE, ANYTIME, ON THEIR DESKTOP

The plant, unit operation, and individual loop health's are all available through the Performance Monitor website. And they are all updated in real-time as more assessment data is available. It cannot be over emphasized enough that the availability of concise assessments and performance analysis through anyone's browser make any problems in the plant transparent to anyone that cares.

Also the prioritized lists, detailed loop history and any other loop parameters are all available via the Performance Monitor website.

CHANGE MANAGEMENT

Another important aspect of the Performance Monitor is the ability to automatically track PID tuning changes. This allows a central place, available to everyone on their desktop, to view changes. Notes can be added about a specific change. Any other event on a particular loop can be added through the browser also, allowing a central, yet totally available location for any other documentation about process changes.

Event Log

Event Log over a week period.
 Ending April 2003

Loop, unit operation or group	Loop types	Pattern match
<input type="text" value="All loops"/>	<input type="text" value="All"/>	<input type="text"/>

[Refresh](#)
[PlantTriage home page](#)
[Help](#)

Time	Loop	P	I	D	Author	Summary
<input type="button" value="Sort"/>	<input type="button" value="Sort"/>	<input type="button" value="Sort"/>	<input type="button" value="Sort"/>	<input type="button" value="Sort"/>	<input type="button" value="Sort"/>	<input type="button" value="Sort"/>
8:05 AM 4/3/2003	LIC100				Joe.Blogs@expertune.com	Tank Shakedown
5:40 AM 3/30/2003	PIC100				john.gerry@expertune.com	Moved probe
10:33 AM 3/28/2003	FIC101	100	0.2	0	john.gerry@expertune.com	P. I changed.
10:27 AM 3/28/2003	LIC100				Joe.Blogs@expertune.com	Re-calibrated xmitter
10:24 AM 3/28/2003	PIC100	12	0.64	0	unknown - please acknowledge	P. I changed.
9:24 AM 3/27/2003	TIC101	350	1.4	0	unknown - please acknowledge	P. I changed.

The history of changes can be viewed for any one loop, group of loops, type of loop, or unit operation. In addition to grouping loops in the history, the time window of history is totally selectable to be for the past X amount of time or for any X window of time in the past. For example, one could look at all the PID tuning changes and events made for any 3 month period in all the temperature loops during the past few years. Or one could look at all the PID tuning changes and events in one unit during the last 2 weeks. A loop with many PID tuning changes in the past week is probably one that is causing problems.

INTEGRATED ON-LINE HELP

One under sung aspect of helping to bridge the resource gap is having documentation about the tools available with just a click. The Performance Monitor includes clickable help links.

Even displays that the user customizes have integrated clickable help links. In custom displays the Performance Monitor automatically links the column heading of an assessment to a help window describing the assessment and how to use it.

CONCLUSION

The Performance Monitor pinpoints the problem and with integrated tools allows the maintenance engineer to further get a quantitative diagnosis of the problem. Finally the engineer can tune and optimize the problem loops. This powerful combination of pinpointing the problem for the engineer and providing the tools to do repair the problem are a tremendous productivity enhancer. Change management allows engineers and technicians to view changes made to a loops.

